

AI-Powered USB Handbook

USB

AI-Powered USB Handbook Team

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1. AI-Powered USB Handbook

| AI-Powered USB Handbook | | | |
|-----------------------------------|-----|-----------------|--------------------|
| AI-Powered USB Handbook Type-C | USB | USB 3.2 Gen 2x2 | Thunderbolt 4 (4) |

1.1

- -
- USB - USB
- USB -
- Thunderbolt -
- - USB PD
- -

1.2

- 
- 
- 
- 

2. 1 (Introduction)

2.1

| | | | | |
|--------------------------------------|-----|----|-----|-----------------|
| USB (Universal Serial Bus) Type-C | | | USB | USB 3.2 Gen 2x2 |
| AI-Powered USB Handbook | USB | AI | | |

2.2

-
- 4 USB4
- USB

2.3

-
- USB 1.0 USB4
- Intel Thunderbolt USB
- USB PD PPS
-

3. 2 USB (USB Connector Types)

USB

3.1 USB Type-A

| | | | |
|------------|---|---|--|
| USB | | | |
| • | | | |
| • | | | |
| • USB 2.0 | 4 | | |
| • USB 3.0+ | 5 | 9 | |

USB Type-A Illustration

3.2 USB Type-B

| | | | |
|---------------------|----------|---------|--|
| • Standard-B | | | |
| • Micro-B (USB 3.0) | Elements | USB 3.0 | |

USB Type-B Illustration

3.3 Mini USB & Micro USB

| | | | |
|-------------|-----|---------|--|
| • Mini USB | MP3 | | |
| • Micro USB | | USB 2.0 | |

Mini & Micro USB Illustration

3.4 USB Type-C

| | | | |
|----------|-------------|---------|----------------------------|
| • | | | |
| • | | | |
| • | DP Alt Mode | 240W | USB PD |
| • | 24 | 22 | CC (Configuration Channel) |
| • Type-C | Type-C | USB 2.0 | 4 |

USB Type-C Illustration

4. 3 USB (USB Transfer Protocols)

USB USB-IF (USB)

4.1

- **USB 1.0 / 1.1:**
- **Low Speed:** 1.5 Mbps ()
- **Full Speed:** 12 Mbps
- **USB 2.0:**
- **High Speed:** 480 Mbps “ ”

4.2 USB 3.x

| | (2013) | (2019) | | | |
|---------|---------------|-----------------|------------------|---------|-----------|
| USB 3.0 | USB 3.1 Gen 1 | USB 3.2 Gen 1 | USB 3.0 / 5Gbps | 5 Gbps | 8b/10b |
| N/A | USB 3.1 Gen 2 | USB 3.2 Gen 2 | USB 3.1 / 10Gbps | 10 Gbps | 128b/132b |
| N/A | N/A | USB 3.2 Gen 2x2 | USB 3.2 / 20Gbps | 20 Gbps | 128b/132b |

USB 3.2 Gen 2x2 Type-C Type-C

4.3 USB4

USB4 Intel Thunderbolt 3

- **USB4 Gen 2x2:** 20 Gbps
- **USB4 Gen 3x2:** 40 Gbps ()
- (Tunneling) (USB 3.2) (DisplayPort) PCIe
- USB 3.2 USB 2.0 Thunderbolt 3

5. 4 Thunderbolt () (Thunderbolt Technology)

Thunderbolt Intel Apple “ ” “ ”

5.1 Thunderbolt 3 (3)

- USB Type-C
- 40 Gbps
- PCIe x4 () DisplayPort (5K/8K) USB
- 3 USB 3.x USB

5.2 Thunderbolt 4 (4)

4 40 Gbps

5.2.1 4 vs 3

- | | | | | | | |
|----------------|---|----------------|--------------------|----------|---------------|-----|
| 1. PCIe | 4 | PCIe | 32 Gbps (3 | 16 Gbps) | (eGPU) | SSD |
| 2. | 4 | 4K | 8K (3 | 4K) | | |
| 3. | | Intel VT-d DMA | DMA | | | |
| 4. | 4 | (Hub) | 1 3 | 3 | (Daisy Chain) | |

5.3 Thunderbolt vs USB4

- USB4 3
-
- **USB4** “ ” 20Gbps 40Gbps PCIe
- **Thunderbolt 4** “ ” 40Gbps PCIe Intel
- **Thunderbolt 4** **USB4** “ ”

6. 5 (Charging & Power Delivery)

| | | |
|-----|----------------|------|
| USB | 2.5W (5V 0.5A) | 240W |
|-----|----------------|------|

6.1

| | |
|--|-------------------------------------|
| • USB BC 1.2 (Battery Charging) | 7.5W (5V 1.5A) |
| • | QC (Quick Charge) OPPO VOOC SCP/FCP |

6.2 USB PD (Power Delivery)

| | | |
|--------|--------|--------|
| USB PD | USB-IF | Type-C |
|--------|--------|--------|

6.2.1

| | |
|------------------------|---|
| • PD 2.0 / 3.0: | 100W (20V 5A) |
| • | 5V, 9V, 15V, 20V |
| • PD 3.1: | EPR (Extended Power Range) 240W |
| • | 28V, 36V, 48V |

6.2.2 PPS (Programmable Power Supply)

| | | | | | | |
|-----|--------|------|---|---|-----|-----|
| PPS | PD 3.0 | 20mV | - | - | “ ” | PPS |
|-----|--------|------|---|---|-----|-----|

6.3 (E-Marker)

| | |
|--------------|--------------------------------------|
| | Type-C |
| • 3A | C-to-C 60W (20V 3A) |
| • 5A | E-Marker “ 5A ” 100W (20V 5A) |
| • EPR | PD 3.1 240W |

7. 6 (FAQ & Common Misconceptions)

7.1 Q: Type-C

A: 1. USB 2.0 E-Marker 3A 65W/100W 2. PD
VOOC 10W 3.

7.2 Q: Type-C

A: Type-C C -9.9 + USB 2.0 - USB 3.2 (10Gbps) + 4K + 100W - 4 40Gbps
+ 8K + 240W Logo

7.3 Q: 65W

A: USB PD “ ” “ 9V 2A ” 18W PD 5V 1A 5V 2A

7.4 Q:

A: - 5A 4 - USB 3.2